

Term Project Checkpoint B

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Introduction

The *Why* for the project holds from Checkpoint A. The goal of this fund is to enable average investors to generate positive returns on relatively “safe” investments. These investments, specifically include ETF funds such as SPY (S&P 500), and TLT (Treasury Bonds). To diversify the portfolio, the Vanguard Total Stock Market (VTI) ETF was added as well. The VTI is known to be another passive index fund, which coincides with most buy and hold strategies. VTI is also famous for incredibly low expense ratios which aligns with the values of this fund (Investopedia, 2024).

In this portion of the project pipeline, a few experiments were conducted to help build on Checkpoint A. The first was a simple quadratic programming experiment to try and locate what percentage of starting capital should be allocated to each ETF, and what the average annual return might look like. The second, was to complement this approach with a Monte Carlo simulation. This stochastic model accounts for randomness and produces returns over a distribution of possible outcomes, instead of a fixed return. This is important because, as alluded to in the previous report, there are several economic factors that can happen at random that would affect the return of our investments.

Literature Review

Quant analysts Carlo Zarattini and Andrew Aziz have conducted research in the past few years that investigates possible alternatives to the buy and hold strategy this firm proposes. It is possible the philosophy of this firm will pivot, and become more flexible as further research is performed. In their article, *Can Day Trading Really Be Profitable?*, the pair tested the Opening Range Breakout (ORB) strategy against two bear markets from the years 2016-2023 in the QQQ ETF, which tracks the Nasdaq 100 index (2023). Zarattini and Aziz claim that from their research, they have concluded that day trading can produce “significant returns when compared to a standard buy and hold strategy on benchmark indexes in the US public equity markets (Nasdaq or NYSE)” (2023).

While the Opening Range Breakout is specifically not featured in this portion of the project pipeline, there is consideration for it down the line. The study itself was influential to highlighting

potential issues with buy and hold, and perhaps that other trading strategies can generate excess returns for our clients.

Methods

Before the fund is comfortable with day trading strategies, a few experiments need to be performed testing the buy and hold strategy with chosen assets SPY, TLT, and VTI. The first experiment was a quadratic programming test that aims to achieve the “best” hypothetical results for our investors based on historical data for our assets obtained through Yahoo! Finance. This experiment used the daily log returns from our historical data and from that metric we were able to obtain the covariance matrix, standard deviation (volatility), and the Sharpe Ratio and generate the optimal allocation, or weights, for our portfolio. It should be noted that for this program, there were a few constraints that helped define the problem. First: all weights must sum to 1. This is a standard rule, ensuring that all assets are used and cannot equal more than we have. Second: to follow our initial strategy, we must eliminate short selling. There were upper and lower bounds constructed for the experiment. The lower bound was 0, meaning that no negative weights can be held in any asset, and we must only take long positions (buy and hold). The upper bound was 0.5 to ensure that no more than 50% of the portfolio was allocated to one particular asset. This helps ensure diversification, and prevents an “all eggs in one basket” situation.

At the very least this method ensures that we can stay on pace with market averages, however, it cannot take into account the random external factors that can occur over the investment period. To try and incorporate some randomness into the testing, a Monte Carlo simulation was performed. The simulation was run with our three chosen ETFs across 700 random portfolios. In the simulation, a True/False boolean variable was used to indicate the long position only nature of the portfolio strategy. The same log daily returns obtained from the historical data were used as well.

As mentioned earlier in the report, the fund will begin to experiment with different trading strategies to compare against our buy and hold strategy. The final method was to backtest a momentum strategy known as RSI (Relative Strength Index) strategy. Momentum strategies follow trends, and in this

case, the RSI indicator is looking for recent price gains versus recent price losses. It measures how strong the recent upward price movements have been compared to the downward movements. The RSI period was set to 14 days, which is a common starting place in this kind of testing. The same goes for the values of 30, and 70, which are the lower and upper thresholds respectively. When the RSI falls below the lower threshold, this usually means the asset is oversold, or simply that the price of the asset has fallen rapidly over the recent period. If the RSI were to fall below this level, and then rise above it, it would generate a buy signal in a mean-reversion strategy. What does this mean for our investors? Well, if the RSI would fall below the lower threshold – meaning it's oversold – then this would tell our investors to buy the asset anticipating an upward reversal in the price and profiting from the difference when they sell later. This strategy is much different than our buy and hold, where we don't care about price movements, and we've eliminated short selling.

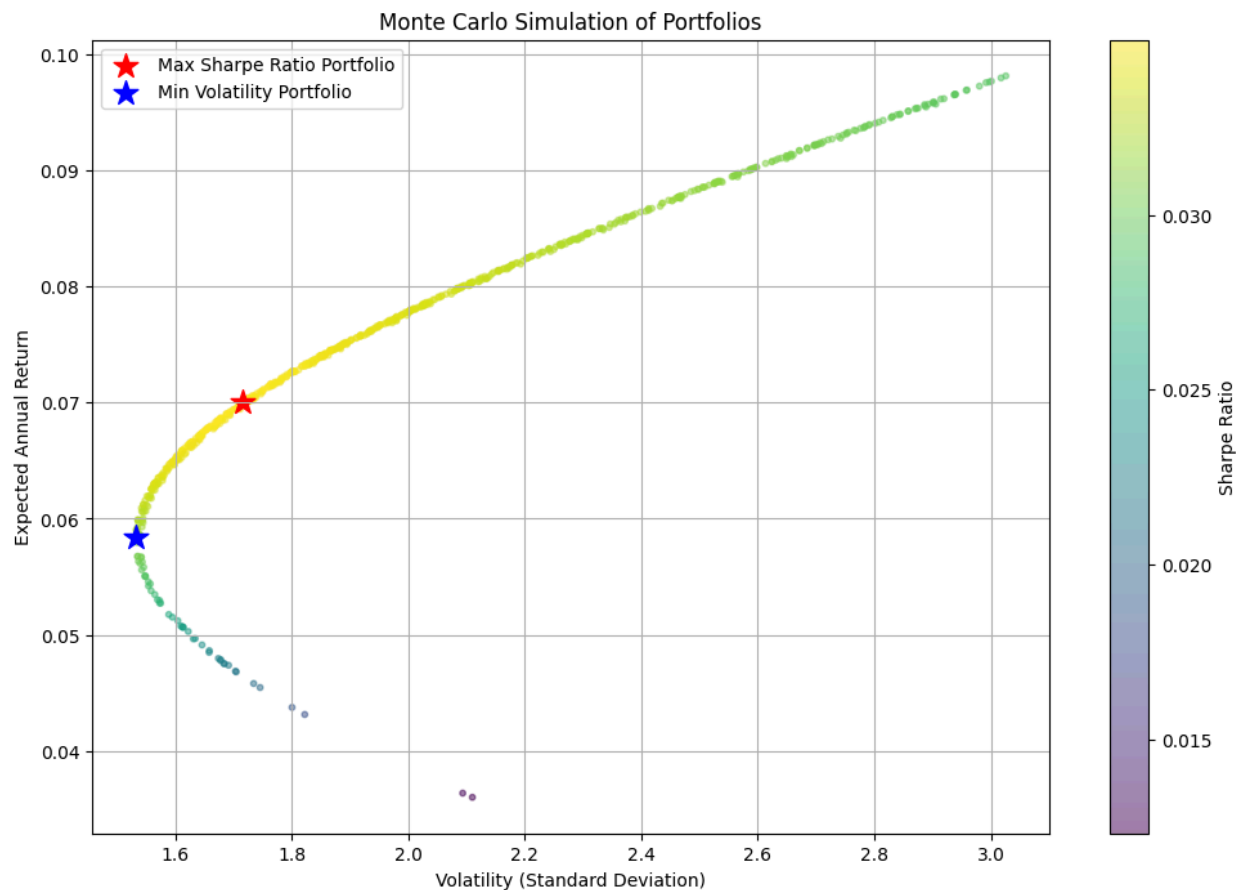
Results

Quadratic Program

The quadratic program found that our investors can generate around a 10% annual return on their initial investment. This is a solid expected return. Based on the historic average, according to SoFi, the S&P 500 index generates around a 7% annual return when adjusting for inflation, and the U.S. Stock Market itself usually generates around the same 10% as well. When it comes to the optimal portfolio weight allocation, the program suggests that our investors should not invest in the TLT fund, and split the SPY and VTI indexes 50-50. This is a surprise due to the historically low-risk nature of investing in U.S. Treasury Bonds.

Monte Carlo Simulation

The simulation produced the 700 possible portfolio allocations as stipulated in the parameter setup. These points were graphed on the following Efficient Frontier:



Each plot point represents one of the portfolios generated by the simulation process. As you can see, the portfolios farthest to the right generate excess returns, albeit with high volatility and risk. The two portfolios that were singled out were Min Volatility Portfolio, which is the portfolio with the historically lowest volatility, and the Max Sharpe Ratio portfolio. This portfolio is the point with the highest Sharpe Ratio in the simulation, as denoted by the heat bar on the right. This is considered to be the most “efficient” of the generated portfolios given its corresponding volatility (risk). As defined by Investopedia: “The Sharpe ratio describes how much excess return you receive for the extra volatility you endure for holding a riskier asset” (Lioudis, 2025).

RSI Momentum Backtesting

The return % for the RSI momentum strategy is -94.13%.. However, the buy and hold return % was 631.24%. To interpret this for our investors, if you followed the RSI-recommended buy and sell

strategies, then you would lose over 94% of what you invested. On the other hand, if you executed the buy and hold strategy, then the value of the asset – in this case SPY – increased 631.24% over the investment period, which drastically outperforms the RSI test. The annual return following the RSI strategy also equates to around a -13.23% loss. For this strategy we've instituted a 5% commission fee, and our investors are starting with \$10,000. Given these rules, it is safe to conclude that this would be a pretty disastrous loss for our investors over the 20 year investment period

Conclusions

Ultimately, from the results of these experiments, the buy and hold strategy generated the best results for our investors. However, the fund is open to alternative trading strategies such as Open Range Breakout, SMA Crossover, etc. and will continue to research them for future work. The RSI is also not out of the question, despite poor performance. The RSI can be optimized and altered with various parameters to try and outperform our buy and hold position. Concerns for the project arise when considering what happens to the fund when new investment capital is introduced into the equation. There is also concern for continuing to refine simulations and experiments to account for external, macroeconomic events that can disrupt our expected returns.

References

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